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CONTROLLING GRASSHOPPERS IN ALFALFA  
WITH CHLORDANE AND TOXAPHENE SPRAYS

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The control of grasshoppers is an important problem to the alfalfa seed grower in areas where these pests are likely to occur. In the last 15 to 20 years grasshoppers have become so well established in alfalfa-seed fields in western South Dakota and Nebraska that they are an annual threat to both hay and seed crops. For this reason alfalfa-seed growers have used poisoned bait more consistently and more persistently than any other group of farmers. Although these growers have sometimes obtained excellent results with the bait, their failures have so far outnumbered their successes that a more reliable method of control is needed.

The alfalfa field is an ideal place for using the spray method to destroy a grasshopper infestation. The plant growth is sufficient to catch and hold the spray, and the margins, whether ditch banks or fence rows, are usually lush with vegetation in which grasshoppers concentrate during any movement out of or into the alfalfa. Thus a field of alfalfa or the areas bordering it can be used as traps where chlordane and toxaphene can be applied to destroy grasshoppers moving in from much larger areas when the small grains are harvested.

Entire farms and fields in the alfalfa-seed areas around Buffalo Gap, S. Dak., in 1948 and Crawford, Nebr., in 1949 were utilized for testing both chlordane and toxaphene sprays to protect the alfalfa-seed crop from grasshoppers and reduce local infestations to a minimum. These two areas were selected because of their long history of grasshopper damage to alfalfa, and because large quantities of poisoned bait had been used in them at various times without giving very effective control. The investigation was continued in 1950 with treatments of lightly infested marginal areas.

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<sup>1/</sup> This work was done in cooperation with the Division of Grasshopper Control of this Bureau and the Sugar Loaf Soil Conservation District, Crawford, Nebr.

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## MATERIALS AND METHODS

The chlordane spray used in the Buffalo Gap area consisted of 1 pound of technical chlordane dissolved in 1 quart of No. 1 petroleum distillate with 25 ml. of Igepal CA Extra High Concentrate (a condensation product of ethylene oxide and an alkylated cresol) and water to make 4 gallons. Some of the chlordane spray used in the Crawford area was the same formulation, except that in place of the Igepal a granulated commercial soap substitute was used at the rate of a handful per gallon of distillate. However, in most of the tests an emulsion concentrate containing 8 pounds of chlordane per gallon was used. One pint of this concentrate in water sufficient to make 4 gallons of spray was applied per acre with a mist blower.

Some of the toxaphene spray used in the Buffalo Gap area consisted of 2 pounds of technical toxaphene dissolved in 1 gallon of No. 1 petroleum distillate with 100 ml. of Igepal CA Extra High Concentrate and sufficient water to make 4 gallons. Other sprays were concentrates containing either 4 or 6.9 pounds of technical toxaphene per gallon. In the Crawford area a concentrate containing 8 pounds of technical toxaphene per gallon was used. Enough water was added to make a spray that would give the desired dosage.

All the sprays were applied with a mist blower. A side-delivery nozzle was used in all the spraying. Although a level field might best be sprayed with a rear-end-delivery nozzle, in these alfalfa fields the interspersed variety of marginal areas could be reached only with a side-delivery nozzle. Considerable maneuvering and retracing of distances were thus avoided. Furthermore, the side-delivery nozzle on this blower-type sprayer was much preferred by the farmers to their own boom-type sprayers.

The sprayer was calibrated to deliver 8 gallons of liquid with the truck traveling  $1/2$  mile at 10 miles per hour and covering a strip 2 rods wide, or at the rate of 4 gallons per acre. At this calibration the recommended dosage per acre for either insecticide determined the quantity of emulsion concentrate that went into the 50-gallon sprayer tank. Since a speed of 10 miles per hour could not always be maintained, records were kept of the quantity of spray used on a known acreage.

In all areas 1 pound of chlordane or 1.5 pounds of toxaphene per acre was generally used for early spraying of grasshopper nymphs in the first four instars and for spraying entire fields, and 1.5 pounds of chlordane or 2 pounds of toxaphene per acre for spraying late nymphal and adult infestations and barrier strips. In the Crawford area in 1949, lighter dosages of both sprays were tested in the initial applications.

The dosages of technical material were the same as those that the farmer would use in his own spray operations. From the strength of the concentrate he could calculate the amount needed for use in his spray tank.



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delay in spray operations--waiting until the hay was dry enough to be taken off the fields and for the roadways to become passable--allowed some of the grasshoppers to spread from the alfalfa into adjacent small-grain fields and doubled the area to be treated.

General observations indicate that, to protect an alfalfa-seed crop adequately from grasshopper damage, the numbers of grasshoppers in the field must be held to less than 5 per square yard. This means that where there are 50 or more grasshoppers per square yard 90 percent or higher mortality must be obtained, preferably with one application of insecticide. To prevent movement of grasshoppers out of the alfalfa or reinfestation of the crop from hatching grasshoppers or from some outside infestation, the insecticide should show a marked residual effect over a period of 1 to 3 weeks. Chlordane and toxaphene sprays have this quality.

### Results

Table 1 summarizes the results with chlordane and toxaphene sprays applied for the control of grasshoppers in seed alfalfa at Buffalo Gap in 1948 and the effect of residues from these sprays on infestations in 1949.

Altogether 255 pounds of chlordane were sprayed on 50 acres of alfalfa and on 132 acres of margin and adjacent cropland at the average rate of 1.4 pounds per acre. This rate was high, mostly because in one 55-acre contoured wheatfield (NW 1/4, sec. 10, fig. 1) the ground was rough and slowed up the speed of the truck. The heavy dosage was intentional where a long residual action was desired (NE 1/4, sec. 8, fig. 1). On the contoured wheatfield, the north half of which was first sprayed with 1.3 pounds of chlordane per acre on July 8 when the wheat was in the dough stage and the foliage was drying up, the kill was only 85 percent, whereas 95 to 100 percent is usually obtained with this dosage of chlordane. The lower kill was attributed to the lack of succulent green foliage in the wheat. Previous tests in ripening small grain had given similar results. A hailstorm during the night of July 11 destroyed over half of the wheat crop in this field, but on July 13 grasshoppers were dying from the effects of the spray. On August 12 chlordane was applied to the south half of this field, where grasshoppers had concentrated in a heavy growth of sweetclover covering a third of the field, and the infestation was practically eliminated. In sections 8, 9, and 10 where chlordane was used, the infestations were reduced 94 to 100 percent.

About 650 acres of alfalfa and 338 acres of adjacent land, approximately 85 percent of the total area sprayed at Buffalo Gap, were treated with 1,607 pounds of toxaphene at the average rate of 1.6 pounds per acre. Populations were reduced 90 to 100 percent.

Table 1. --Field tests with chlordane and toxaphene sprays for the control of grasshoppers in seed alfalfa in 1948, and their effect on infestations in 1949. Buffalo Gap, S. Dak.

Section	Area sprayed		Total insecticide used	Grasshoppers per square yard before spraying <sup>2/</sup>		Reduction in 1948	Egg pods per square foot fall of 1948 <sup>2/</sup>	Grasshoppers per square yard, July 16, 1949 <sup>2/</sup>	Reduction in 1949 from treatments in 1948
	Acres	Acres	Pounds	Number	Percent				
	Alfalfa <sup>1/</sup>	Adjacent			Chlordane				
10	0	72	112	18	94		0	1	99+
9	50	35	111	60, 400	98+		0.1, 0	0, 4	98+
8	0	25	32	200	100		-	3	97
<u>Toxaphene</u>									
10	50	20	165	40, 200	95+		0, 2	0, 6	98+
9	100	28	212	20, 150	95+		.1	1-	99+
4	120	77	334	40, 400	95+		0, .1	1, 5	97
5	50	20	100	40, 150	95+		0, .8	0, 2	99
33	50(120)	6	85	20, 30	90+		0, .7	1-	99+
32	100	12	197	20, 200	100		0	1-	99+
29	40( 85)	14	72	10, 200	95+		0	0, 1	99+
19, 30	70(120)	12	115	15, 300	93+		.05	0, 1	99+
21	60	140	293	20, 600	95+		0, .1	0, 3	99+
31	10( 60)	9	34	40	80+		0	-	-
Total	700(915)	470	1,862	30, 268	94+		0.02, 0.28	0.3, 2	98
or average									

1/ Same acreage protected unless otherwise indicated by numbers in parentheses.

2/ Figures in the first column refer to the population in the field and the second to that in the margins.

## Protection of Area Sprayed

A total of 1,170 acres were sprayed in this area in 1948 to protect 915 acres of seed alfalfa, or 1.28 acres sprayed for every acre protected. In practically every test the initial spraying eliminated the infestation. When the alfalfa was first cut, some of the grasshoppers moved to the margins and adjacent fields. This migration reduced the numbers of grasshoppers 30 to 50 percent in alfalfa fields 20 to 60 acres in size, and 50 to 100 percent in smaller fields. Grasshoppers escaping into adjacent fields were either sprayed in these fields or were kept out of the alfalfa by the use of sprayed barrier strips consisting of weedy margins or the first 8 or 10 rods of the alfalfa itself. From two to four applications on these barriers at 5- to 10-day intervals were required to keep them effective until all threatening reinfestation was eliminated.

Three small alfalfa fields in the eastern half of section 19 totaled 20 acres. The weedy banks of a creek formed the margins of these fields. After the first alfalfa cutting all the grasshoppers from the alfalfa concentrated in these weedy margins, where they averaged about 300 per square yard. A single application of toxaphene to 6 acres of these weeds on June 14 destroyed nearly all the infestation originating in these three fields.

At the other extreme the infestation on a 30-acre alfalfa field in the SE 1/4 of section 4 was not eliminated until 163 pounds of toxaphene had been sprayed on 93 acres in seven treatments. The hay was cut on June 14, but was not raked until June 23 because of heavy rains. A small part of the field had been sprayed on June 3, but the largest part was not treated until June 25. Because it was not possible to spray the entire field soon after the first cutting, the original infestation spread over about three times the area it originally occupied. The increase in the area requiring treatment, including most of the wheatfield adjacent on the east, explains why on an average 1.28 acres had to be sprayed to protect 1 acre of alfalfa.

Most of the survey to determine the numbers of eggs laid in 1948 was made in the spring of 1949. Egg deposition for the entire area was extremely low, the number of egg pods averaging a maximum of 0.1 per square foot in the fields and 0.8 in the margins (table 1).

## Effect of Spraying on Subsequent Infestations

To determine the effect of the 1948 spraying operations on the populations in the Buffalo Gap area, a survey was made on July 16, 1949, when most of the grasshoppers were in the late nymphal or adult stage. The greatest number of grasshoppers within the fields was 1 and in the margins, 6 per square yard. It thus appears that the spraying in 1948 gave almost complete control of grasshopper infestations that year and the following year.

The only control needed in the entire area during 1949 was accomplished with 17 pounds of toxaphene sprayed on 10 acres of spotted infestations in sections 9 and 10. The survey in July 1949 did show a 6-acre infestation averaging 15 grasshoppers per square yard in a grove of trees in the NE 1/4 of section 4. It had been the intention of the owner to spray this area, but by the time he got around to it the grasshoppers had moved south into the 30-acre alfalfa field in the SE 1/4 of section 4 and damaged about 15 percent of the northern two-thirds of the alfalfa. The species, mostly Melanoplus differentialis and M. bivittatus, had laid their eggs along the fence rows forming the northern and northwestern margins of the alfalfa field. The number of egg pods averaged 4 per square foot. From 10 to 15 pounds of toxaphene and 1 hour of time would have wiped out the original infestation. However, this infestation was wiped out in 1950, when these margins were sprayed with 10 pounds of toxaphene soon after the eggs had hatched. Other spotted infestations on the area were eliminated by the use of approximately 15 pounds of toxaphene.

The tests at Buffalo Gap (table 1) indicate that 90 to 100 percent reduction in infestation in one year by early-season sprays will carry over into the following year. On the other hand, experience has shown that any reduction less than 90 percent offers no assurance that grasshoppers will not be a threat the following season.

This situation was evident in Lyman County, S. Dak., where a large-scale experiment to compare the efficiency of baiting and spraying was conducted in 1947 (Shotwell 1). In 2 fields 3 or 4 baitings between July 29 and August 10 reduced the numbers of grasshoppers 70 and 85 percent. Just before the baiting in the first field, which was then in corn, the population was 3 hoppers per square yard within the field and 25 along the margins. In August of the following year there were 10 hoppers per square yard within the field, then in wheat, and 20 along the margin. In the second field, which was then in strips of wheat and corn, the population just before the baiting was 20 hoppers per square yard within the field and 40 along the margins. In August 1948 there were 10 hoppers per square yard in this field, which was then in strips with the corn and wheat reversed, and 30 along the margins, although some control work was done early in the season. In the field where the reduction was 70 percent in 1947, the infestation was greater in 1948. In the second field where the reduction was 85 percent in 1947 and some control work was done in 1948, the infestation in 1948 was still more than half as much as in 1947.

In the same area of Lyman County 7 fields were sprayed with chlordane or toxaphene in 1947. The populations ranged from 1 to 200 per square yard in the fields and 20 to 1,000 along the margins, and were reduced 94 to 100 percent by the treatments. In August 1948 the populations averaged less than 1 per square yard in the fields and 7 along the margins. On 2 sections containing 4 of these fields, 58 pounds of toxaphene was sprayed on 35 acres of marginal infestations. The other 3 fields were

not treated. Although no complete survey of the sprayed fields was made in 1949, the owners reported that few grasshoppers were present. In 1950 the only control needed to hold down infestations in the 7 fields was spraying 23 acres of light marginal infestations on 2 farms. It is now stated positively by the farmers in this area that, because of the new insecticide sprays, they no longer worry about grasshopper damage to the corn. Before 1947 all the fields and the general area had had a long, continuous record of grasshopper infestations dating back to 1930.

At Buffalo Gap in 1949 the yield of alfalfa seed from the area sprayed in 1948 was estimated to average more than 2 bushels per acre. The year 1950 was a poor alfalfa-seed year throughout this region. The work and observations carried on in the Buffalo Gap area in 1948-50, and in Lyman County in 1947-50 show that very satisfactory results can be obtained by the proper use of toxaphene and chlordane sprays for the control of grasshopper infestations.

#### TESTS AROUND CRAWFORD, NEBR.

In the Crawford area in 1949 single alfalfa fields 15 to 60 acres in size were used. These fields were scattered throughout an area of range and farm land, 15 miles square, lying north of Crawford, where the combined acreage of small grain and corn was much greater than the alfalfa acreage. The 12 fields where the tests were made are shown in figure 2.

Melanoplus bivittatus was the dominant species in the alfalfa and M. mexicanus was second in numbers. A few M. differentialis hoppers were present in spots. Some spraying of young and hatching nymphs was done in June, but most of the tests were made in July in fields containing late-instar and adult grasshoppers. Little previous information was available concerning the location of infested fields, and spray operations had to await the reports of farmers. The populations in these fields numbered 10 to 60 grasshoppers per square yard and in the margins, 20 to 300.

In addition to these tests, a close record was kept of some of the grasshopper-control operations conducted by farmers on the Sugar Loaf Soil Conservation District lying north and west of Crawford. This district comprises about 220,000 acres of privately owned and 75,000 acres of government-owned land, with about 5,000 acres of alfalfa scattered throughout. A spray-control campaign against grasshoppers, sponsored by the district board of supervisors, was conducted here in 1949. Bureau personnel making the spray tests helped in this campaign.

## Objectives

An important factor to be determined in the Crawford area was the effect of grasshopper infestations in adjacent range land on attempts to protect the alfalfa-seed crop from damage. Large expanses of open range land surrounding crop land have always caused some farmers to consider grasshopper control in crops as hopeless. The usual reasoning has been that when the range grasses dry up all the grasshoppers will move into whatever crop is still standing and destroy it, thus nullifying any good accomplished by earlier control measures in that crop. Harvested small-grain fields are notable sources of reinfestation of late crops, including alfalfa, but in northwestern Nebraska infestations on open range land are seldom a threat to such crops.

Collections were made in both grass lands and alfalfa to determine the species found in each type of infestation. Each test was conducted with the idea of destroying first the initial infestation in the field and then any reinfestation from outside, whether adjacent crop or grass land. All infestations were therefore fought from within the alfalfa field except in field 12 (fig. 2), where an attempt was made to wipe out the entire infestation on a single farm. Most of the spraying on this farm was done along the margins and in weedy places adjacent to the crop land.

To determine how light a dosage could be safely used in a general spray-control program, on some fields light dosages of both chlordane and toxaphene were used until heavier dosages were needed to save the crops.

Another objective of the work in the Crawford area was to determine the quantities of residue from the chlordane or toxaphene sprays present in the threshed straw from the treated fields of seed alfalfa. Alfalfa straw is used as feed, and it is important to know how much insecticide remains in the pile after threshing.

## Results

The results of the tests made at Crawford in 1949 are recorded in table 2. Any single treatment of a whole or part of a field is considered as one application. The numbers of grasshoppers shown before the spraying are representative figures for peak infestation which developed during the field test, and the reduction of infestation is based on a comparison of the population left at the end of the field test with that shown before the spraying.

From June 9 to July 8, 502 pounds of toxaphene and 330 pounds of chlordane were sprayed on 326 acres of alfalfa and 108 acres of margins and weedy spots to protect 390 acres of alfalfa. Field populations of 10 to 60 grasshoppers per square yard were reduced to 0 to 5 and marginal infestations of 20 to 300 per square yard to 1 to 10, a reduction of 80 to 99 percent. The egg survey in the fall showed a maximum of 0.4 egg pod per square foot in the field and of 0.6 in the margins, which are extremely light infestations.

Table 2.--Field tests with chlordane and toxaphene sprays for the control of grasshoppers in seed alfalfa.  
Crawford, Nebr., 1949

Field	Period of operation	Total area sprayed		Appli- cations	Total insecticide used		Grasshoppers per square yard before spraying <sup>2/</sup>	Reduction of infestation	Egg pods per square foot October 1949 <sup>2/</sup>
		Alfalfa <sup>1/</sup>	Adjacent		Initial application per acre	Total			
Chlordane									
1	July 24	29	5	1	1.5	50	30	97	0
3	July 18, 25	24	1	2	1.5	54	30	90	0.2, 0.6
4	June 14 to July 25	60	12	4	.5	106	25, 50	98	0, 0.2
6	July 15, 27	45(75)	4	2	1	60	60, 100	95	0
8	July 27	24	-	1	1.5	36	10, 20	99+	0
10	June 23 to July 13	16	-	3	.5	24	25, 35	88	0
Toxaphene									
2	June 28 to July 26	22(32) <sup>3/</sup>	3	3	.75	86	27, 40	80	0.4, 0
5	July 6 to July 25	28	6	3	1	78	40, 70	98	0
6	July 14	10(0) <sup>4/</sup>	-	1	1.5	15	60	75	-
7	June 14, July 18	28	8	2	1	72	20, 75	90	0
9	June 23 to July 30	26	-	3	.75	59	25, 35	92	0
10	July 30	12(16) <sup>4/</sup>	-	1	2	24	5, 8	-	-
11	July 13	18	9	1	1.3	36	25, 40	92	0, 0.4
12	June 9 to July 28	6(30)	60	3	1	132	50, 300	99+	0, 0
Total or average		326(390)	108	2.3	-	832	30, 70	94	0.05, 0.1

<sup>1/</sup> Same acreage protected unless otherwise indicated by numbers in parentheses.

<sup>2/</sup> Figures in the first column refer to the population in the field and the second to that in the margins.

<sup>3/</sup> Sweetclover instead of alfalfa.

<sup>4/</sup> This acreage also included in that sprayed with chlordane. The toxaphene was applied by owner in same field.

## Economy of Minimum and Heavier Dosages of Toxaphene and Chlordane

As indicated in table 2 all or part of seven fields received a minimum dosage in the first spray application, followed by heavier applications if necessary to protect the field.

Field 2 (fig. 2) was 32 acres of sweetclover, half of which was cut for hay and the other half saved for seed. Melanoplus bivittatus in the second to fifth instars was the dominant species in the infestation, which averaged 27 grasshoppers per square yard in the field and 40 along the margins (table 2). On June 28 the half cut for hay, and its margins, were sprayed with toxaphene at the rate of 0.75 pound per acre. Six days later no evidence of residual action was noted and the number of grasshoppers was reduced 40 percent. On July 20 and again on July 26 the same half was sprayed at the rate of 2 pounds of toxaphene per acre. It was fairly windy on July 20 and only a 30-percent kill was obtained. The poor results were probably due to the small amount of foliage on the sweetclover stubble. The total reduction in numbers was 80 percent for the entire 32 acres.

Four acres on the east end of field 9 (fig. 2) was sprayed with 0.75 pound of toxaphene per acre on June 23 (table 2). A 35-percent reduction in the numbers of grasshoppers was obtained, and no residual action was indicated after 6 days. The rest of this field to the west, about 22 acres, was sprayed on the same day at the rate of 1 pound of toxaphene per acre. A reduction of 80 percent in numbers was obtained, and the residual action lasted 10 days. On July 13 the entire field was again sprayed at the rate of 1 pound per acre, because the infestation then averaged 10 grasshoppers per square yard. On July 30, 4 acres was given a third treatment at the rate of 2 pounds of toxaphene per acre. As a result of all applications the infestation was eventually reduced 92 percent.

On the same farm, just 1/4 mile east of field 9, field 11, containing 18 acres of alfalfa and 9 acres of crested wheatgrass and margins, was sprayed on July 13 with 36 pounds of toxaphene at the average rate of 1.3 pounds per acre. There were 25 to 40 grasshoppers per square yard in this field, mostly Melanoplus bivittatus adults. The one application reduced the numbers to 2 per square yard. Since this field was completely surrounded by open range land, no reinfestation occurred and the one application was considered sufficient.

In fields 5, 7, and 12 (fig. 2) the first application of the toxaphene spray was at the rate of 1 pound per acre. Field 5 was first sprayed on July 6 (table 2), when the alfalfa was 18 inches high and the grasshoppers were in the last two instars and adult stage. Of the population, which numbered 40 to 70 per square yard, 78 percent were Melanoplus bivittatus and 12 percent M. mexicanus. An 80-percent kill was obtained with the first treatment, the residual action lasting 9 days. A wheatfield adjacent on the south was a source of continuous reinfestation as the wheat ripened and was harvested. Two more applications of toxaphene were

made on 12 acres of the margins and on a barrier across the south end of the field, 18 pounds on July 15 and 24 pounds on July 25, to obtain the final 98-percent reduction in numbers.

In field 7 some early spraying of third to fifth instars of Melanoplus bivittatus and M. mexicanus mexicanus was done on June 14 and 15 on 6 acres of alfalfa and 10 acres of margins at the rate of 1 pound of toxaphene per acre. The residual action lasted 9 days, with 95-percent reduction in population. Before the spraying there were 15 grasshoppers per square yard in the alfalfa and 75 along the margins. On July 18 a second spray was applied at the rate of 2 pounds of toxaphene per acre on 10 acres of old alfalfa and also on 12 acres of newly seeded alfalfa and 2 acres of margins, all of which had not been previously sprayed. At this time the populations were 15 to 25 per square yard in both the fields and margins, and all were adults. The field sprayed on June 14 did not need a second treatment. Infestations on this farm were reduced 90 percent by the two applications.

Tests in field 12 were begun on June 9 and 10, when 36 acres of margins and weedy places were sprayed at the rate of 1 pound of toxaphene per acre. Melanoplus bivittatus was the dominant grasshopper and was in the first to fourth instars. A few first to third instars of M. mexicanus mexicanus were also present, while M. differentialis was either just hatching or in the first instar. At this time few grasshoppers were in the alfalfa on this farm, but the margins and weedy places contained 10 to 300 per square yard. Almost 100-percent kill was obtained with the first treatment, and the residual action lasted 6 days.

As a result of heavy infestation in the weedy creek bottom and some infestation in the small grain, field 12 was partially reinfested after the residual action of the toxaphene had ceased. On July 19, when all the grasshoppers were adults, 72 pounds of toxaphene was sprayed on 36 acres of creek bottom and field margins and on 6 acres of alfalfa at the rate of 2 pounds per acre. Most of this area had not been sprayed previously, and the grasshoppers numbered 50 to 100 per square yard. This second treatment reduced infestations to 1 per square yard in the weedy creek bottom, which had been a source of infestation on this farm for several years. A third spraying of 24 pounds on 12 acres of previously sprayed margins was made on July 28 to eliminate infestations still existing on the farm.

Light dosages of chlordane were tried out in fields 4 and 10. On June 14, 8 acres of the margins of 60 acres of alfalfa in field 4 were sprayed with chlordane at the rate of 0.5 pound per acre. The grasshoppers were hatching and the alfalfa hay was being cut. Populations in half of the field averaged 10 per square yard and 20 to 150 in 1/8 mile of margin. A 95-percent kill was obtained in the areas actually sprayed, but 6 days later the residual action had ceased.

On July 1, when the infestation numbered 25 grasshoppers per square yard in the field and 50 in the margins, chlordane was sprayed on the 60 acres of alfalfa and on 12 acres of margins at the rate of 0.5 pound per acre. Melanoplus bivittatus, in all stages of development, was the dominant species. This application killed 70 percent of the grasshoppers, and the residual action lasted 8 days. On July 12 another 30 pounds of chlordane was sprayed on the 60 acres, which then had a population of 15 grasshoppers per square yard. A reduction of only 65 percent was obtained. At this time the wheat to the north and the oats to the west had been or were being cut. Reinfestation from these small-grain fields plus the poor kills obtained by the light dosages made a fourth spraying necessary on the margins and parts of the field where the numbers had again increased to 10 to 15 per square yard. On July 25 chlordane was applied at the rate of 1.5 pounds per acre on 24 acres of the south, west, and north parts of the field. This treatment completed 93 percent reduction of the infestations--no grasshoppers in the field and only 3 per square yard along the margins. The treatments enabled the owner to obtain 48 bushels of alfalfa seed from 45 acres of the alfalfa in this field. Dry weather conditions cut his seed production, but there was no damage by grasshoppers.

In field 10, 16 acres of alfalfa containing 25 to 35 fourth and fifth instars and adults of Melanoplus bivittatus per square yard were sprayed with chlordane at the rate of 0.5 pound per acre on June 23. By June 29 50-percent reduction in numbers and some evidence of residual action were observed. On July 6 the population was 10 to 15 per square yard. On July 13 a second spray at the rate of 1 pound of chlordane per acre reduced the infestation to 5 grasshoppers per square yard. At this time a small wheatfield on the western edge was harvested, and a reinfestation from this field kept the population in the alfalfa up to 5 per square yard. To prevent any further reinfestation, the owner sprayed 12 acres of the western end and margins with 24 pounds of toxaphene. The population dropped to 3 per square yard for an over-all reduction of 88 percent of the original numbers. The last two applications were made when all the grasshoppers were adults.

Better results were obtained and fewer applications were made where a heavier dosage of chlordane was used in the first application. In field 6, 24 pounds of chlordane was sprayed on 25 acres of alfalfa on the west side of the farm on July 15. An infestation of 60 grasshoppers per square yard was mostly Melanoplus bivittatus from the third instar to adults. The stages indicated a late hatch. The alfalfa was 1-1/2 to 2 feet high, dense, and beginning to bloom. The one application reduced the numbers to 3 per square yard--95-percent kill. On July 27, 4 acres of the eastern edge was sprayed again with 6 pounds of chlordane to take care of a small reinfestation from a harvested wheatfield in the creek bottom.

Of 100 acres of alfalfa on the east side of the creek in field 6, 10 was sprayed with 15 pounds of toxaphene on July 14 and 20 acres with 30 pounds of chlordane on July 27, the combined sprays reducing the infestation 95 percent.

Fields 1, 3, and 8 were sprayed at the rate of 1.5 pounds of chlordane per acre on alfalfa 1 to 2 feet high after the grasshoppers had become adults.\* The one application was sufficient in fields 1 and 8, but a second application was necessary in field 3 because of a reinfestation from a harvested wheatfield.

In all tests the lighter dosages of toxaphene or chlordane were not sufficiently effective. Repeated applications and increased dosages were essential to save the alfalfa seed crop. Heavier initial dosages, however, reduced the number of applications by at least one and gave more satisfactory results. On an average, three applications were necessary in fields where light dosages were used at the beginning and only 1.4 in fields where heavier dosages were used in all treatments.

### Effect of Range Land Infestations on Grasshopper Control in Alfalfa

As previously mentioned, one objective of the tests at Crawford was to study the effect of native grassland infestations on the control of grasshoppers in alfalfa. Most of these tests were made in alfalfa partially or wholly surrounded by native grasslands (fig. 2). The species of grasshopper collected in four alfalfa fields and adjacent grasslands are given in table 3.

One alfalfa field, field 5, had a crested wheatgrass pasture adjacent to it on the west, and beyond this open range land (fig. 2). The grasshopper population in the pasture averaged 50 per square yard, mostly Ageneotettix deorum, but this species was not found in the alfalfa. After the grasshoppers in the crop, largely Melanoplus bivittatus and M. mexicanus, had been destroyed by the toxaphene spray, the alfalfa was not reinfested with A. deorum coming from the crested wheatgrass. The population decreased more or less normally in the pasture--from 50 per square yard on July 23 to 20 on August 31.

There was no movement of the range species of grasshoppers from adjacent grass and pasture lands, other than of Melanoplus mexicanus into fields 3, 4, and 6 (table 3 and fig. 2), and none of these grass or pasture lands were sprayed. The populations in the native grassland in the respective fields were 15, 16, and 10 per square yard when spray operations were begun in the alfalfa. The species in the alfalfa fields had moved in considerable numbers from 3 to 6 rods into the adjacent grasslands. They continued to move back into the alfalfa until they were all killed by the residual action of the spray and only the range species were left in the grass.

Table 3. --Percentages of various species of grasshoppers collected in alfalfa and adjacent grasslands, Crawford, Nebr., 1949

Species	Field 3				Field 4		Field 5		Field 6
	July 23		August 31		July 23		July 23	Aug. 31	August 31
	Alfalfa	Grass	Alfalfa <sup>1/</sup>	Grass	Alfalfa	Grass	Alfalfa	Grass	Grass
<u>Ageneotettix deorum</u> (Scudd.)	-	28	-	33	3	5	-	32	98
<u>Amphitornus coloradus</u> (Thos.)	-	53	-	35	-	5	-	2	-
<u>Arphia pseudonietana</u> (Thos.)	-	-	-	-	-	-	-	-	4
<u>Aulocara ellioti</u> (Thos.)	-	-	-	-	-	-	-	5	1
<u>Boopedon nubilum</u> (Say)	-	-	-	-	-	-	-	-	2
<u>Hadrotettix trifasciatus</u> (Say)	-	-	1	-	-	-	-	-	-
<u>Hesperotettix speciosus</u> (Scudd.)	-	-	-	-	-	-	2	-	-
<u>viridis</u> (Thos.)	-	-	-	-	-	11	-	-	-
<u>Hypochlora alba</u> (Dodge)	-	-	-	-	-	-	-	-	2
<u>Melanoplus angustipennis</u> (Dodge)	-	3	5	-	19	-	-	1	-
<u>bivittatus</u> (Say)	47	-	14	-	36	5	78	-	-
<u>confusus</u> Scudd.	-	-	-	-	1	-	-	-	-
<u>dawsoni</u> (Scudd.)	-	-	-	-	-	4	-	-	2
<u>differentialis</u> (Thos.)	3	-	1	-	-	-	-	-	-
<u>discolor</u> (Scudd.)	-	-	-	-	-	5	-	-	-
<u>femur-rubrum</u> (Deg.)	3	-	4	-	1	-	5	-	-
<u>keeleri luridus</u> (Dodge)	-	-	-	-	-	-	-	-	2
<u>mexicanus mexicanus</u>									
<u>(Sauss.)</u>	44	4	65	13	36	22	12	0.3	17
<u>packardii</u> Scudd.	3	5	9	2	3	4	2	-	4
<u>Mermeria maculipennis</u> Bruner	-	1	-	-	-	24	2	-	33
<u>Opeia obscura</u> (Thos.)	-	1	-	7	-	-	-	-	-
<u>Phoetaliotes nebrascensis</u> (Thos.)	-	1	1	-	-	15	-	1	2
<u>Spharagemon collaris</u> (Scudd.)	-	-	-	-	-	-	-	0.4	-
<u>Trachyrhachis kiowa</u> (Thos.)	-	3	-	2	-	-	-	-	-
Unidentified nymphs	-	-	-	9	-	-	-	-	-
Number of specimens collected	64	74	85	46	69	55	59	366	221
									46

<sup>1/</sup> Collections from alfalfa in field 3 and 6 were combined by mistake. These fields are not over 5 miles apart.

## Organic Chlorine in Straw From Seed Alfalfa

To determine the residues from the chlordane and toxaphene sprays in threshed straw from seed alfalfa, samples from several treated fields and from two fields that had not been sprayed were analyzed for organic chlorine, as shown in table 4.<sup>2</sup> Ten samples were taken from each field, and from field 6 ten additional samples from the areas treated with both chlordane and toxaphene. In fields 3 and 4 and in a field treated by a farmer himself all samples were taken from a single stack, in field 5 five samples from each of two stacks, and in field 6 two samples from three stacks and four from a third stack.

Because field spraying included marginal and strip spraying the coverage was uneven. The greatest difference in residues was in field 5. One of the two stacks contained most of the straw from the south end of the field, which had been sprayed most heavily. The average amounts of organic chlorine from all fields ranged from 4 to 11 p.p.m.; the highest for any sample was 26 p.p.m.

The organic chlorine analyses were made on aliquots representing 120 grams of alfalfa. Samples from two unsprayed fields, analyzed by the same technic, did not show a measurable quantity of organic chlorine in excess of that found in the reagent blank.

## DISCUSSION

Grasshopper infestations in alfalfa and adjacent fields, field margins, and waste areas in a solid block of farm land can be reduced 90 to 100 percent in a single season by the use of toxaphene or chlordane sprays. This reduction persists through at least 2 years. Small local infestations, however, may materialize in bad years in spite of excellent control the first year. Although these infestations may cause little injury to the current crop, they are an incipient source of reinfestation and should be destroyed.

An alfalfa field that is a source of infestation should be sprayed at least once. The application should be made after the first cutting of hay has been taken off the field and before the new growth is more than 6 inches high. By that time most of the grasshoppers will have hatched. Failure to recognize the significance of an inconspicuous infestation of 10 or more first- and second-instar nymphs per square yard, or failure to spray an alfalfa field because of inclement weather, preoccupation with other farm work, or mere neglect before the pests have grown and spread widely through the field, may allow a two- or three-fold increase in the area of infestation.

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<sup>2/</sup> These determinations were made at the Vincennes, Ind., laboratory of the Division of Insecticide Investigations.

Table 4. --Organic chlorine in straw from seed alfalfa from fields sprayed with chlordane or toxaphene. Crawford, Nebr.

Field	Number of applications	Area treated	Total insecticide per acre	Organic chlorine from 10 samples per field	
				Range	Average
		<u>Acres</u>	<u>Pounds</u>	<u>P. p. m.</u>	<u>P. p. m.</u>
Chlordane					
3	1	12	1.5	}	8-23
	2	12	3		
4	2	21	1	}	3-10
	3	24	2.5		
6	1	25	1		1-9
					4
Toxaphene					
5	1	12	1	}	1-26
	2	4	2.5		
	3	12	4.5		
Sprayed by farmer	1	15	1.6	}	5-9
	2	14	2.9		
Toxaphene and Chlordane					
6	1 (toxaphene) 1 (chlordane)	10	3	2-7	5

After the initial treatment of an alfalfa field it is usually necessary to spray the margins and parts of the field one or more times to protect it from reinfestation, which comes chiefly from small-grain fields adjacent to alfalfa. Infestations in these fields are often unnoticed and of no consequence to the crop itself, but when the grain is cut and the grasshoppers move into a much smaller acreage of alfalfa their numbers become serious: Barriers against reinfestation from the outside may be made by spraying weedy fence rows or border strips 4 to 10 rods wide within the field.

The range-land species that were numerous in the grasslands near Crawford, Nebr.--mostly Ageneotettix deorum, Amphitornus coloradus, and Mermeria maculipennis Bruner--did not leave the grass for the alfalfa even after the grass had dried up. However, some Melanoplus mexicanus grasshoppers did move from adjacent range land into the alfalfa, where they were destroyed by the residual action of the sprays. Controlling such species as M. mexicanus, M. bivittatus, and M. differentialis, which normally infest cultivated crops, was the main problem in protecting alfalfa from grasshoppers.

In both the Buffalo Gap and Crawford areas it was demonstrated that weedy places close to a crop which harbor severe infestations nearly every year can be sprayed so effectively that alfalfa fields are not re-infested from them for at least 2 years.

The best results against grasshopper nymphs early in the season were obtained when 1 pound of chlordane or 1.5 pounds of toxaphene per acre was used. When the grasshoppers were adults, the best results were obtained when the dosage was increased to 1.5 pounds of chlordane or 2 pounds of toxaphene per acre. Although these were not the minimum effective dosages, they were found to be the best, because they had a longer residual action and would give practical control under most conditions. Lighter dosages made it necessary to increase the number of applications to a point where the total quantity of spray used to protect a field was equal to or greater than that used when heavier dosages are applied in the first treatment.

Heavy rains seemed to have little effect on the residual action of either spray, unless they fell within an hour after the spraying. Winds up to 15 miles an hour during spray applications did not seem to affect the results in tall vegetation and even helped to distribute the spray, but in sparse or short vegetation best results were obtained when the air was quiet.

The results were not so good in vegetation that had dried up or lost its leaves so that only bare stems were present to catch the spray. Succulent vegetation seemed necessary for best results.

Two main difficulties were observed in the farmer use of the sprays: (1) Many farmers were unable to calibrate spray equipment so as to obtain the proper dosage because of the lack of information concerning

the quantity of chlordane or toxaphene contained in 1 gallon of the different commercial spray concentrates; and (2), most farmers seemed unable or unwilling to recognize, appraise, and control any type of grasshopper infestation before crop damage became apparent.

Organic-chlorine analyses showed that residues were present in the straw from seed alfalfa that had been sprayed with either chlordane or toxaphene. The greater the total amount of insecticide used on a field the more organic chlorine was found in the straw.

Caution. --Straw from fields treated with chlordane or toxaphene should not be fed to dairy animals, to meat animals being finished for slaughter, or to poultry.

#### LITERATURE CITED

(1) Shotwell, R. L.

1949. The comparative effectiveness of poisoned bait and sprays for grasshopper control in Lyman County, S. Dak., 1947. U. S. Bur. Ent. and Plant Quar. E-771, 22 pp.

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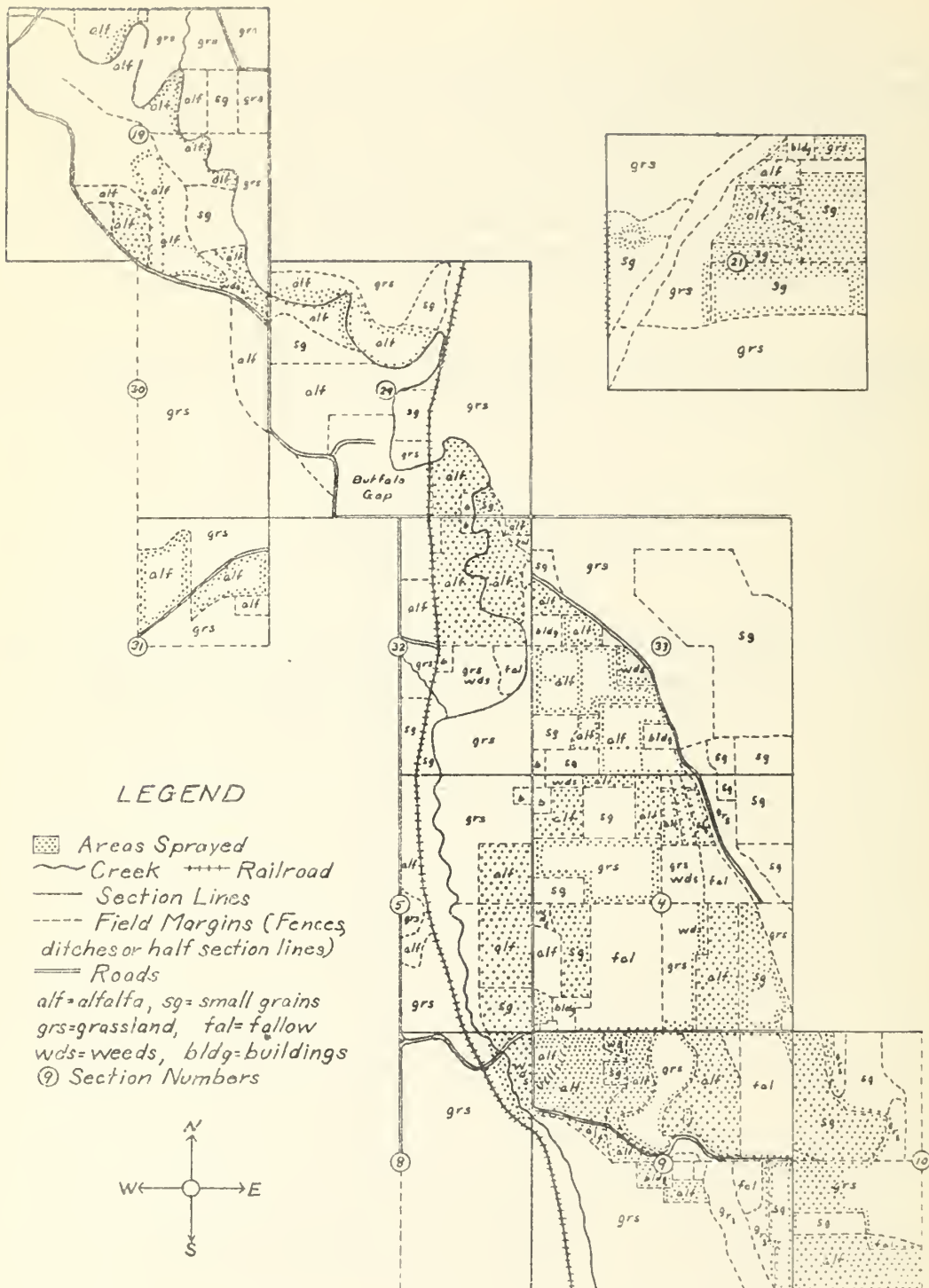


Figure 1. --Seed-alfalfa areas in various sections near Buffalo Gap, S. Dak., sprayed with chlordane or toxaphene for the control of grasshoppers, 1948.

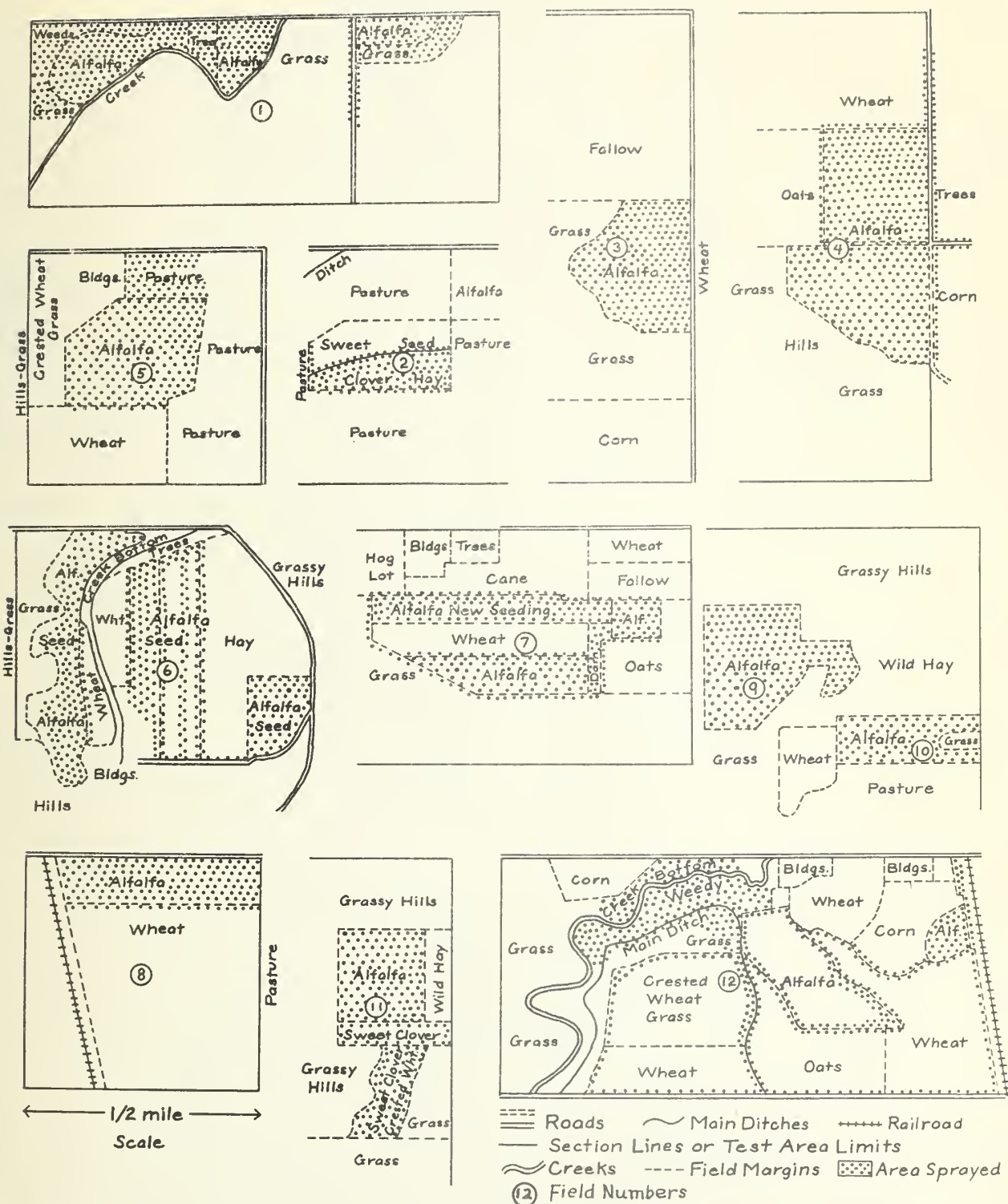


Figure 2. --Fields of seed alfalfa near Crawford, Nebr., sprayed with chlordane or toxaphene for the control of grasshoppers, 1949.

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